Private Labels and Bargaining in the Supply Chain

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Abstract

I estimate the role of private label products on vertical (manufacturer-retailer) relationships. I first propose a new model of bargaining in the vertical channel in which firms negotiate bilaterally over *both* wholesale and retail prices. I estimate this model using data on US domestic wine sales in 2015 and supplementary data on prices from states in which the sale of wine is controlled by the state. I show that wholesale prices and bargaining parameters can be identified from these two datasets. On average, I find that bargaining power and the resulting division of channel profits are roughly even between retailers and manufacturers, but larger firms tend to have higher bargaining power and channel profit share. I next study how retailers use private label products to improve their bargaining position with manufacturers, and I find that offering private label products significantly increases retailers' profit from national brands compared with a no-private label scenario. I compare the conclusions from my model with those of other prominent models of the vertical channel and show that my model better fits the data. From a managerial perspective, I demonstrate how to use the model to determine how best to position a new private label product in quality space. JEL Codes: L1, L81, M31

Keywords: private labels, bargaining, vertical relationships, wine

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I would like to thank Simon Anderson, Federico Ciliberto, Gaurab Aryal and Daniel Savelle for guidance in writing this paper. I would also like to thank Ken Wilbur, Mitch Lovett, Danial Asmat, and Kenneth Elzinga for their comments. Finally, I thank Jerry Janicki at NABCA for assistance in data collection.

Introduction

Private labels, or store brands, have become more popular with consumers in recent years (Dubé, Hitsch, & Rossi, 2018). Usually associated with providing good value, private label products are also becoming associated with higher quality than in the past. Major retailers, including Walmart (Great Value brand) and Amazon (Amazon Basics brand), offer a wide range of private label products across multiple categories. As a result, their strategic effects have attracted attention by researchers. These effects include increasing store loyalty (Ailawadi, Pauwels & Steenkamp, 2008) and retailers' ability to use private labels in a strategic manner when dealing with national brand manufacturers (Meza & Sudhir, 2010; Ailawadi & Harlam, 2004; Draganska, Klapper, & Villas-Boas, 2010), have attracted the attention of researchers. The latter observation leads to the following questions: Does having a private label increase bargaining position of retailers vis-à-vis manufacturers, and if so, by how much? How do private labels affect the distribution of profit between retailers and manufacturers? And how can competing retailers best respond to private label competition?

I answer these questions in this paper. In particular, I study the extent to which retailers use private labels to improve their bargaining outcomes with national brand manufacturers in the specific case of the US domestic wine market. I chose this market because there are only a few major domestic wineries, which makes estimating the bargaining game tractable. I focus on large retailers rather than liquor stores because only large retailers offer private label products, and in this case only one of the retailers in my data offers private label wine. Also, by studying wine I am able to leverage data from alcohol control states when estimating the bargaining model. These estimates allow me to quantify the impact of private labels on retailer and manufacturer profits.

In terms of methodology, I develop a theoretical model of bargaining between retailers and manufacturers. Each retailer and manufacturer negotiates the wholesale price and the retail price of that manufacturer's products. Previous retail bargaining studies assume that the parties can only negotiate over the wholesale price, but this assumption is lacking. The wholesale-only bargaining model assumes that upstream and downstream firms cannot contract over downstream prices, yet it also assumes that retailers cannot adjust prices if there is a breakdown in bargaining, which is a seeming contradiction. In addition, I show that both sides can achieve higher profits in partial equilibrium by coordinating over retail and wholesale prices rather than only wholesale prices, so it stands to reason that if there are no legal barriers to this arrangement, firms will choose to use the two-price contract. As it turns out, these vertical contracts are not illegal per se in the US as outlined in the Supreme Court ruling *Leegin Creative Leather Products, Inc. v PSKS, Inc.* (2007). In addition, there is much anecdotal evidence of coordination in the vertical channel, including promotional pricing and frequent communication; this further supports a model that allows for a higher degree of pricing coordination. From the researcher's perspective, I show that allowing for retail and wholesale price bargaining requires that one observes either wholesale prices or marginal costs to identify the parameters of the model. In contrast, wholesale price bargaining does not require this data for identification.

The profits earned by retailers and manufacturers in this model depend primarily on two aspects: bargaining power, which captures some notion of negotiating skill, and bargaining position, which is each side's outside option if negotiations break down. PLs affect the outside option: A profitable private label makes the retailer less dependent on the national brand, and thus the retailer improves its bargaining position. However, the general equilibrium effects of offering a private label are unclear from the theory alone, so how private labels affect all firms in a market is an empirical question.

I use data on product sales and retail prices to estimate the model. I do not observe wholesale prices in the retail scanner data. As part of my identification strategy, I therefore use data from alcohol control states for the same set of products in order to estimate the marginal costs of production. With these marginal cost estimates, I show that I am able to estimate the negotiated wholesale prices between retailers and manufacturers in non-alcohol control states, as well as the bargaining power parameters. I am unaware of other work that uses data on a common set of products whose prices are negotiated by a different entity in estimation. On average, I find that both bargaining power and the share of profit going to each side is roughly evenly split between retailers and manufacturers, but larger firms tend to have higher bargaining power and a higher share of channel profit.

I use the estimates to evaluate profits in two counterfactual scenarios. First, I treat private labels (henceforth PL) as national brands (henceforth NB) in order to isolate the effect of PLs on pricing and profits. I find that the retailer that offers the private label earns on average 17.6% higher profit on its NB sales than in the no-PL scenario. However, competing retailers and manufacturers are harmed by the PL to varying degrees for different reasons: Manufacturers are harmed by the increase in the PL retailer's bargaining position, while competing retailers are harmed due to the PL retailer's becoming a stronger competitor. In a second counterfactual, I determine the optimal quality choice of a new PL product offered by a non-PL retailer. This exercise provides an example of how this work can guide managers when introducing a new PL line.

Finally, I compare estimated market outcomes from my model with models that ignore the vertical channel (Nevo, 2000); linear pricing upstream and downstream (classic double marginalization); and wholesale-only bargaining (Draganska, Klapper, & Villas-Boas, 2010). I show that the conclusions differ significantly based on the chosen supply-side model and that my model best rationalizes the data when using the same marginal cost estimates.

The paper proceeds as follows: Section 2 is the literature review, Section 3 describes the mass-market wine industry, Section 4 outlines the theoretical model, Section 5 outlines the empirical model, Section 6 discusses identification, Section 7 describes data, Section 8 contains estimation results, Section 9 describes the effects of the private label on firm profits, Section 10 discusses optimal private label product placement, and Section 11 presents comparisons to other supply-side models.

Literature Review

A rich literature models bargaining in the vertical channel. In terms of theory, Iyer and Villas-Boas (2003) and Dukes, Gal-Or, and Srinivasan (2006) outline models of channel bargaining over wholesale prices only. Empirically, Ailawadi and Harlam (2004), Pauwels and Srinivasan (2004), and Meza and Sudhir (2010) all show that PL margins are higher than NB margins, but high PL share is associated with higher NB margins. However, none of these studies estimates a bargaining game between manufacturers and retailers.

Draganska, Klapper, and Villas-Boas (2010) estimate a model of bargaining over wholesale prices. Retailers and manufacturers choose wholesale prices to solve the Nash bargaining problem, and there is Nash-Bertrand competition among retailers. They find that retailer bargaining power is positively correlated with higher quality PL offerings (measured by the ratio of the price of the PL good to an average of NB goods in that category). Ellickson, Kong, and Lovett (WP) use the previous model but apply it to a setting with exogenous private label introduction to identify the effects of private label entry on market outcomes. Their setting is the introduction of private label K-cups, which entered the single-cup coffee market after Keurig's patent expired. They find that offering a PL increases retailer profits, and that the net benefits from bargaining (increased margins on NB goods minus the cannibalization of NB sales) account for 20% of the increase in retail profits due to PL introduction.

While the previous two studies estimate bargaining models, they also allow for a low degree of coordination in the vertical channel (and in the case of Meza and Sudhir (2010), no coordination). In contrast, there is empirical evidence supporting the use of complex contracts—and thus channel coordination—in the grocery industry. Villas-Boas (2007) compares various vertical pricing models using data on yogurt sales. Using a non-nested model test, she finds little evidence of linear pricing (and thus double marginalization) in the vertical channel. Similarly, Bonnet and Dubois (2010) use data on French bottled water sales to test different vertical supply models. They find that two-part tariffs with resale price maintenance contracts best fit the data. These results suggest that there is a high degree of channel coordination in the grocery industry, and therefore my model better approximates this fact than previous studies.

Finally, a small literature exists on the optimal product design of PLs. Morton and Zettelmeyer (2004) find that retailers have an incentive to position PLs close to NBs in categories that feature an NB with high market share. They argue that PLs are necessary in this case because other NBs have an incentive not to compete directly with the leading NB. As a result, offering a PL close in product design to the leading NB will provide the largest gains in profit when negotiating with NB manufacturers. I verify this finding in the context of my bargaining model.

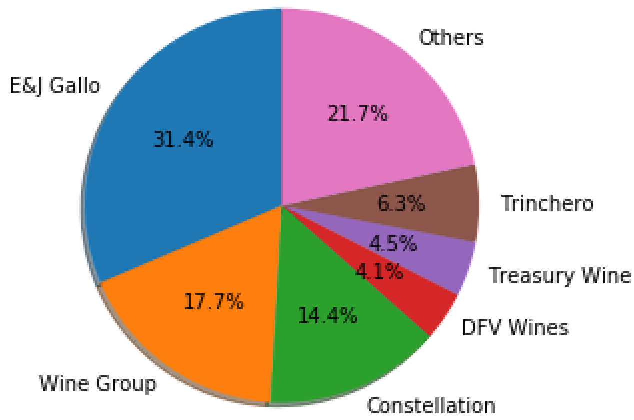
Industry Description

Manufacturers

US wine sales totaled over $13 billion in 2015, with domestic wine sales totaling about $9.5 billion (Wine Business Monthly, 2015). Most of these sales are made on value bottles (less than $15) produced by large wineries: Although there were 9,654 US wineries in 2018, the top 5 wineries by volume produced account for around 68% of sales (Wine Business Monthly, 2018). Figure 1 shows the global market share of the top 10 California producers.[1] In some cases, these wineries own large, diverse portfolios of wine labels that have only grown in recent years due to acquisitions (Wine Business Monthly, 2018).

[1] California is by far the largest wine producer in the US, supplying around 90% of gallons produced (http://wineamerica.org), but my data also includes wines produced in Washington and Oregon.

Figure 1: Top California Wine Producers by Global Market Share, 2017



Source: Wine Business Monthly

These large wineries' top-selling products are often value labels, which are mass-produced and sell for reasonable prices. They are differentiated from more expensive wines based mainly on inputs and economies of scale. The key inputs for winemaking are grapes and barrels for aging. Value wines often do not have a specific appellation, or vineyard location, apart from general terms such as California. Expensive wines, in contrast, often have region-specific appellations (e.g., Napa Valley) or even estate-specific. In many cases, value wines source grapes from multiple large vineyards in cheaper growing regions, such as Lodi in California. The second key input is barrels, which are used to age the wine. Value wines are often aged in stainless steel tanks rather than oak barrels, which are significantly cheaper. Winemakers can infuse wood chips and oxygen into stainless steel-aged wine to impart organic flavor. Finally, large winemakers benefit from economies of scale in production compared with expensive boutique vineyards (Sellers and Alampi-Sottini, 2016).

As for profit figures, an industry survey conducted by Moss Adams, LLP (2013) revealed that US wineries had an average gross profit margin (percentage markup over cost) of 51%. I use this figure as a benchmark when assessing model estimates later in the paper.

Retailers

Wine is sold through supermarkets and mass-market retailers in 35 states. According to Nielsen, almost 30,000 grocery stores sell wine as of December 2014, and these stores accounted for about 42% of total off-premise wine sales that year (Nielsen, 2015). While in the past large retailers might have offered only a few value labels, retailers are now expanding their wine offerings to cater to many price points; Nielsen reports that the average supermarket sells around 360 different wine products in a week (Nielsen, 2015). Retailers are keen to offer well-stocked wine aisles because of its complementarity with purchases in other departments: On average, consumers spend an extra $13 on other groceries when purchasing a bottle of wine (Nielsen, 2015).

Another recent trend is the growth of private label wine. Private label wines began appearing on store shelves around 2003 with the launches of Costco's Kirkland label, Target's Wine Cube, and Trader Joe's Charles Shaw (Wallace, 2017). Many retailers now offer private label wines which are either "linked" to the retailer's name, such as Kirkland at Costco, or "de-linked" from the retailer's name, such as Acronym at Kroger or Animist at Whole Foods (Wallace, 2017). Figure 2 contains a list of major retailers and their associated private label wines.[2]

In terms of anecdotal evidence of price coordination with manufacturers, a wine buyer for a supermarket chain in the western US stated that retailers and suppliers communicate (at least indirectly through distributors) "every single day" about pricing. I take this as supporting evidence that retailers and manufacturers bargain over both wholesale and retail prices. I am not arguing that there is widespread resale price maintenance in the wine industry, but rather that manufacturers might have more influence over retail

[2]Retailer names will be masked for the rest of this study, as per Nielsen's user agreement.

Figure 2: Notable Private Label Wines

Retailer	**PL Brands**
Costco	Kirkland
Target	Wine Cube, California Roots
Trader Joe's	Charles Shaw
Whole Foods	Animist, Criterion, Wine Farmer, Songbird Cellar
Kroger	Acronym, Parker's Estate
Sam's Club	Member's Mark
Aldi	Broken Clouds, 30 Miles

Source: IBWSS

prices than is allowed for by models with lower degrees of pricing coordination.

Complexities

There are two complexities in the wine market that I do not address in this study: distributors and PL producers. The majority of wine sold in the US passes through a three-tier distribution system, in which dedicated distributors act as the middleman between wineries and retailers. This is a holdover from the post-Prohibition Era, when states decided that such a system would make it easier to regulate and tax alcohol. Currently, distributors are either private companies or state monopolies in every state except Washington, which ended its *de jure* three-tier system in 2011. While recognizing that this layer exists in the supply chain, I ignore distributors in this study. This simplification is justified because I focus only on large retailers and wineries; both likely have high degrees of bargaining power with distributors.

The second complexity I do not address in this study is the identity of the PL suppliers. Many PL wines are produced either by other NB wineries or dedicated PL wineries. However, in this study I treat PL wines as being directly owned by the associated retailer (that is, retailers are vertically integrated with their PL wineries). First, in many cases it is difficult to determine which winery produces the PL. Second, this assumption allows me to estimate the bargaining game without having marginal cost data for the PL. In the Estimation section, I show how I need marginal cost data to estimate the model for NBs, but assuming the retailer owns the PL means that wholesale price is equal to marginal cost. Finally, there is anecdotal evidence that the retailer has almost complete control over the PL channel. I interviewed a handful of wine manufacturers who stated that most PL wine is either excess capacity from large wine producers or wine produced by PL-only wineries. In both cases, it stands to reason that retailers have higher bargaining power when negotiating prices for PL products.

Theoretical Model

I outline a general model of the bargaining game between any number of retailers and NB manufacturers. Let i index a product, where each product belongs to a manufacturer-retailer pair. Let R be the set of retailers and M be the set of manufacturers. Let G_r be the set of all products offered by retailer r and H_m be the set of products produced by manufacturer m. Denote the retail price of product i as p_i, wholesale price w_i, and unit cost c_i. I assume the retailer is vertically integrated with its private label producer, and the rest of the network is exogenous. On the supply side, the retailer solves the Nash bargaining game with each manufacturer independently for each product offered by that manufacturer, choosing a wholesale and retail price for the particular product. Demand for products is then realized in both cases.

Demand

Consumers pick the product in the market that gives them the greatest utility. I denote the indirect utility for consumer n from purchasing product j as $V_{jn}(\epsilon_{jn})$, where ϵ_{jn} is a heterogeneous, unobserved match value distributed $F(\epsilon)$. Consumers also have the outside option of no purchase, in which case they receive utility $V_{0n} = \epsilon_{0n}$.

Expected demand for product j is then $D_j = \int_\epsilon Pr(V_{jn} > V_{kn} \forall k \neq j) dF(\epsilon_n)$. In the empirical application, I will assume ϵ is distributed type I extreme value, thus leading to a closed-form expression for D_j. I also need to define demand in case negotiations break down over product i. I assume that in this counterfactual case, product i is removed from the retailer and no other changes take place. Then, demand for product j is $D_j^{(-i)} = \int_\epsilon Pr(V_{jn} > V_{kn} \forall k \neq \{j,i\}) dF(\epsilon_n)$. As a result of this demand specification, $D_j^{(-i)} \geq D_j$; that is, expected demand for product j cannot decrease when product i is removed from the network. Note that $D_i^{(-i)} = 0$, since i is removed in case of disagreement.

Retail and Wholesale Price Bargaining with the Private Retailer

In the supply-side game, retailers negotiate independently and bilaterally with each manufacturer over the wholesale price w_i and retail price p_i for product $i \in G_r \cap H_m$, given prices for all other products. I model the negotiation process using Nash bargaining, which maximizes the weighted joint surplus of the two parties. Retailer surplus is the difference in retailer profits when offering all goods versus removing product i. Let $\Pi_r = \sum_{j \in G_r} D_j(p_j - w_j)$ be retailer r's profits when all products are offered. If there is a disagreement in negotiations over product i, then the retailer's profit is $\Pi_r^{(-i)} = \sum_{j \in G_r} D_j^{(-i)}(p_j - w_j)$. I interpret $\Pi_R^{(-i)}$ as the retailer's outside option. Retail and wholesale prices are fixed in the disagreement case because I assume that prices for all other goods are fixed during negotiations with manufacturer m (called the passive beliefs assumption in the bargaining literature).[3] Therefore, the retailer's surplus from offering product i is $\Pi_R - \Pi_R^{(-i)}$. In a similar manner, define manufacturer m's profit from selling its products as $\pi_m = \sum_{j \in H_m} D_j(w_j - c_j)$, and define the disagreement profit as $\pi_m^{(-i)} = \sum_{j \in H_m} D_j^{(-i)}(w_j - c_j)$. Therefore, manufacturer m's surplus from selling product i is $\pi_m - \pi_m^{(-i)}$.

Given the surplus expressions defined above, retailer r and manufacturer m jointly pick w_i and p_i to solve the following problem:

$$\max_{p_i, w_i} \left[\Pi_r - \Pi_r^{(-i)}\right]^{\lambda_{rm}} \left[\pi_m - \pi_m^{(-i)}\right]^{1-\lambda_{rm}}. \tag{1}$$

λ_{rm} is retailer r's exogenous relative bargaining power with manufacturer m and is common across all negotiations between the two parties. Bargaining power captures all unmodeled aspects of bargaining.[4] λ_{rm} can take values between 0 and 1, and $\lambda_{rm} = 0.5$ means the sides have equal bargaining power. If the retailer has advantages over the manufacturer for reasons outside my model, then $\lambda_{rm} > 0.5$. The assumption that the retailer is vertically integrated with its PL is equivalent to setting $\lambda_{rm} = 1$.

The first-order conditions of the Nash bargaining game with respect to p_i and w_i are as follows:

$$\sum_{j \in G_r \cap H_m} (p_j - c_j)\frac{\partial D_j}{\partial p_i} + \sum_{j \in G_r - H_m} (p_j - w_j)\frac{\partial D_j}{\partial p_i} + \sum_{j \in H_m - G_r} (w_j - c_j)\frac{\partial D_j}{\partial p_i} + D_i = 0 \tag{2}$$

$$(1 - \lambda_{rm})(\Pi_r - \Pi_r^{(-i)}) - \lambda_{rm}(\pi_m - \pi_m^{(-i)}) = 0. \tag{3}$$

The retailer plays this game simultaneously with all other manufacturers and for all other products.[5] For a private label product L, Equation 3 (FOC with respect to w)

[3]This assumption is logically consistent in a model of retail price and wholesale price bargaining because all other prices are specified by their contracts and cannot be adjusted unilaterally. This is in contrast to the wholesale-only bargaining model, which assumes passive beliefs but also assumes that retailers have the ability to change prices unilaterally.

[4]λ captures all aspects that affect the bargaining outcome apart from the outside option. This could include negotiation skill, patience, etc.

[5]I assume that the two sides can only negotiate over one product at a time, rather than negotiating

says that $w_L = c_L$ because $\lambda_{rL} = 1$ by assumption. This means that the retailer sets the integrated retail price for the private label. In equilibrium, p_i^* and w_i^* solve the first-order conditions, given that all other retail and wholesale prices are at their equilibrium values. This is the Nash-in-Nash equilibrium, which is a Nash equilibrium over simultaneous Nash bargaining games (refer to Ho and Lee (2017) for more information on the Nash-in-Nash equilibrium). To better understand the properties of this problem, note that the retail pricing first-order condition is identical to the retail pricing first-order condition when retailer r and manufacturer m are vertically integrated:

$$\max_{p_i} \sum_{j \in G_r \cap H_m} (p_j - c_j) D_j + \sum_{j \in G_r - H_m} (p_j - w_j) D_j + \sum_{j \in H_m - G_r} (w_j - c_j) D_j. \tag{4}$$

This game is not equivalent to one in which industry profit is maximized (i.e., the multiproduct monopolist problem) because there are externalities imposed on channel i from non-commonly owned products. However, holding all other contracts fixed, both parties would prefer to bargain over both retail price and wholesale price rather than just wholesale price (refer to the Appendix for the proof). Retailer r cares about its margins on products not produced by m, and m cares about its margins on products not sold by r. This makes the pricing game similar to a model of partial ownership. Also, note that neither bargaining power nor bargaining position between the two sides explicitly enters the retail pricing first-order conditions for product i. These variables only affect the split of channel profit and not the size of the pie in partial equilibrium. In general equilibrium, the bargaining powers related to products in the sets $G_r - H_m$ and $H_m - G_r$ affect retail pricing for product i since those wholesale prices enter the FOC.

a deal for all of manufacturer m's products simultaneously. Allowing for multiproduct negotiation only changes the size of the outside option.

Empirical Model and Estimation

I adapt the general theoretical model to an empirical setting. I do not observe wholesale prices or unit costs, one of which is necessary to estimate bargaining power parameters in this model. Instead, I use data from alcohol control states to obtain estimates of the marginal cost of production, c_j, since I observe the same set of products in both settings. I then show how I can estimate the bargaining power parameters without observing wholesale prices but "observing" marginal production costs.

Marginal Cost Estimation Using Alcohol Control State Data

Alcohol control states have little control over the retail pricing of wine due to fixed markup laws, so I model this market as Nash-Bertrand competition between wine vendors. First, I outline the demand model, which borrows heavily from Nevo (2001). Consumer n has an indirect utility from purchasing product j in market t as follows:

$$V_{njt} = \beta X_j - \alpha p_{jt} + \xi_j + \xi_t + \Delta\xi_{jt} + \epsilon_{njt}. \quad (5)$$

X_j includes a constant and the wine rating and p_{jt} is the price. Following Nevo, I split the valuation of unobserved characteristics into two components, the product-specific component ξ_j and the market-specific component ξ_t, and the market-level deviation from the mean unobserved product valuation, $\Delta\xi_{jt}$. I control for ξ_j and ξ_t by including product and market fixed effects. However, $\Delta\xi_{jt}$ is endogenous to price, assuming that firms observe this value when pricing. I discuss how I address this endogeneity issue in the identification section. Finally, ϵ_{njt} is an idiosyncratic match value that I assume is distributed type I extreme value. For now, the marginal utility of price α is constant across consumers, meaning that the demand model is multinomial logit.[6] Berry (1994) shows that this model becomes a straightforward linear estimation problem:

$$\ln D_j - \ln D_0 = \beta X_j - \alpha p_{jt} + \xi_j + \xi_t + \Delta\xi_{jt}. \quad (6)$$

[6] I plan to estimate a richer demand model in the future.

After estimating demand, I solve for equilibrium price-cost markups from the first-order conditions of the wholesale pricing game. In alcohol control states, manufacturers submit their wholesale price offers to the state liquor boards, and if the state accepts the offer the retail price is set by fixed markup laws. Specifically, manufacturer m in market t solves the following problem:

$$\max_{\bar{w}_{mt}} \sum_{j \in H_{mt}} (w_{jt} - c_{jt}) D_{jt}(p_{jt}). \tag{7}$$

I specify marginal cost as $c_{jt} = a_t c_{jt}$, i.e., there is a market-specific component of marginal cost. This decomposition allows me to use true production costs in the bargaining game, netting out any market-specific costs such as transportation, taxes, distribution, rent, and labor. Define an ownership matrix Ω such that $\Omega_{ij} = 1$ if products i and j are produced by the same manufacturer, and define the matrix of share-price derivatives as Δ. Finally, define the fixed retail markup over wholesale price in market t as ρ_t. Writing the FOCs in matrix form, I obtain:

$$w_t - a_t c_t = (\rho_t (\Omega \circ \Delta_t))^{-1} D_t(p). \tag{8}$$

I use the demand estimates to construct Δ, while Ω, w, s, and ρ are observed. Therefore, I can solve for the implied full marginal costs $a_t c_t$. To obtain the product-specific portion of marginal costs, first define $\tilde{w}_t = w_t - (\rho_t(\Omega \circ \Delta_t))^{-1} D_t(p)$. I then log-linearize equation 8 to obtain the following regression equation:

$$\ln \tilde{w}_{jt} = \ln a_t + \ln c_{jt}. \tag{9}$$

$\ln a_t$ is a market fixed effect, while $\ln c_{jt}$ is treated as the residual. Production costs are then the mean of the exponentiated residual. The residual does not vary much by product, which is consistent with treating the residual as a product-specific cost.

Estimation of Bargaining Game

I now proceed to the main estimation exercise of the study: the bargaining game between private retailers and manufacturers. I first re-estimate demand because private retailers serve different consumers from those served by alcohol control states. However, I use exactly the same demand model as in the previous model, except that in this model I control for advertising variables and retailer fixed effects in this model. With these estimates, I can evaluate disagreement demand $D_j^{(-i)}$ and demand-price derivatives $\frac{\partial D_j}{\partial p_i}$.

On the supply side, I allow for unobserved heterogeneity in marginal cost for product i across markets:

$$c_{it} = \hat{c}_i + \eta_{it}, \;\; \eta_{it} \sim N(0,1). \tag{10}$$

The mean marginal cost for product i is the estimated marginal cost from the state data, and I assume that the unobserved portion of cost is standard normally distributed.[7] This heterogeneity captures unobserved market-specific differences, including transportation costs and taxes.

I obtain estimating equations for the bargaining game by rewriting the FOCs in Equations 2 and 3 as moment conditions (market subscript t is suppressed):

$$\begin{pmatrix} \mathbb{E}\big[\sum_{j\in G_r\cap H_m}(p_j-c_j)\frac{\partial D_j}{\partial p_i}+\sum_{j\in G_r-H_m}(p_j-w_j)\frac{\partial D_j}{\partial p_i}+\sum_{j\in H_m-G_r}(w_j-c_j)\frac{\partial D_j}{\partial p_i}+D_i\big] \\ \mathbb{E}\big[(1-\lambda_{rm})(\Pi_r-\Pi_r^{(-i)})-\lambda_{rm}(\pi_m-\pi_m^{(-i)})\big] \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}. \tag{11}$$

These moment conditions define the Nash-in-Nash equilibrium and must hold simultaneously for every product i in market t. The parameters of interest are λ relative bargaining powers and w wholesale prices. These equations only hold within a market; λ is not constrained to be constant for retailer-manufacturer pairs across markets.[8]

Note that each moment equation contains multiple errors (η unobserved marginal costs), so I cannot use GMM to estimate this model because I cannot solve for one η as a function of parameters and data. Instead, I use Simulated Method of Moments

[7] I am currently studying whether I can relax this assumption, such as making the variance a parameter to be estimated.

[8] I am currently working on estimating a model which constrains λ to be constant across markets for a retailer-manufacturer pair. This would be necessary in order to estimate other parameters that do not vary by market, such as variance of the marginal cost shock η.

(SMM). For each moment condition, I make draws from the distribution of η and take the average of the moment condition across all draws. Formally, let M_t be the set of moment conditions for market t. The estimation algorithm solves the following problem:

$$\min_{\Theta} \; M_t(\Theta)' M_t(\Theta). \tag{12}$$

Identification

On the demand side, the key problem is identifying the price parameter, α. Obtaining an unbiased estimate is pivotal to constructing the demand derivative matrix Δ and the disagreement payoffs. Recalling the indirect utility function in Equation 6, prices are endogenous due to ξ_{jt}, which is the mean unobserved utility from buying product j in market t. Following Nevo (2001), I specify the error term as $\xi_{jt} = \xi_j + \xi_t + \Delta\xi_{jt}$. I include product and market fixed effects to control for ξ_j and ξ_t, respectively, meaning that the only unobservable I cannot control for is $\Delta\xi_{jt}$, the market-specific deviation in average unobserved product valuation. Therefore, I need instruments that are correlated with p_{jt} but not $\Delta\xi_{jt}$. I leverage the panel data and use the average price of product j in all other markets as instruments for $\Delta\xi_{jt}$. The identifying assumption is that prices for the same product in other markets are correlated via common marginal costs, but demand shocks across markets for product j are uncorrelated. These instruments are commonly referred to as Hausman instruments. This assumption is violated in the case of a national ad campaign that shifts demand in a correlated fashion in all markets. However, wineries only spent $91 million on media advertising in 2014 compared to $1.3 billion spent on beer ads (Nielsen, 2015), so these concerns are limited.

On the supply side, the parameters of interest are retail bargaining power λ and wholesale prices w. A unique set of parameters solves the first-order conditions of the bargaining game if there are as many equations as there are parameters. Let k be the number of unique manufacturer-retailer pairs and n be the number of total products in a particular market. Therefore, λ is an $k \times 1$ vector and w is an $n \times 1$ vector. However, there are $2n$ FOCs in each market (retail price and wholesale price FOCs for each product). Since $2n > n + k$ if at least one manufacturer produces multiple products, the system is overdetermined. Therefore, I only include one pricing FOC per manufacturer in estimation but include all NB wholesale pricing FOCs (the PL wholesale pricing FOC is trivial because $w = c$). This means that the system is exactly determined and has a unique solution.

Intuitively, the retail pricing first-order conditions identify wholesale prices, while bargaining power is identified given wholesale prices and disagreement demands in the wholesale price first-order conditions. However, this argument relies on observing some measure of marginal production costs. If costs were not observed, there would be $2n + k$ parameters but only $2n$ first-order conditions and therefore no unique solution. Given the full channel margin $(p - c)$ and disagreement demands, the equilibrium conditions of the model exactly determine the wholesale prices and bargaining power parameters.

Data

I estimate my model using two primary types of data: retail scanner data and alcohol control state data.

Retail Scanner Data

I use Nielsen's Retail Scanner Dataset to obtain sales and retail price data for domestic wines at a set of large US retailers in 2015.[9] For a selection of these retailers' stores, I

[9] Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researcher(s) and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

observe the retail price, units sold, and advertising (in-store display and weekly circular ads) at the store-week-UPC level. These retailers consist of large supermarket chains or mass-market retailers, and only one retailer (coded as 13) sells PL wine products during this time period. I exclude independent liquor stores from the analysis in order to focus on large downstream firms. Retailer names are masked in the data, as per Nielsen's user agreement.

There are 13 unique retailers and 8 unique manufacturers (excluding the PL) in the dataset, although only a subset of them compete in a given market, which I define as a county-quarter. I aggregate sales across all stores owned by the same retailer in a given market. In total, I use data from 58 US counties and include 82 unique products in my sample. I define a product as a brand-color (e.g., Barefoot red). I aggregate products at such a high level in order to limit the number of products over which the retailer and manufacturers must negotiate. One potential issue with this aggregation is that a brand-color can come in multiple sizes (750 mL, 1.5 L, 3 L, etc.). To correct for this, I use liters sold and price per liter as market share and price variables, respectively. I obtain the price per liter by taking the average price across all sizes weighted by the liters sold. Therefore, if 3L is the most commonly sold product size at a retailer, then the aggregated price per liter will reflect that. The Feature and Display variables are interpreted as the number of weeks in a quarter in which any subproduct is advertised. Since my definition of product can include many subproducts (e.g., different sizes and varieties), this number can be much larger than the number of weeks in a quarter. To limit the number of products in estimation, I only include products with greater than a 0.05% market share.

I define the market size as total liters sold in a county-quarter in the Nielsen data. Because I exclude small retailers and products with small market share at the included retailers, the average market share of the outside good is 48.8%. While this is high, the average share of the outside good at a given retailer is 24%. That is, I am capturing most of the sales made by the included retailers.

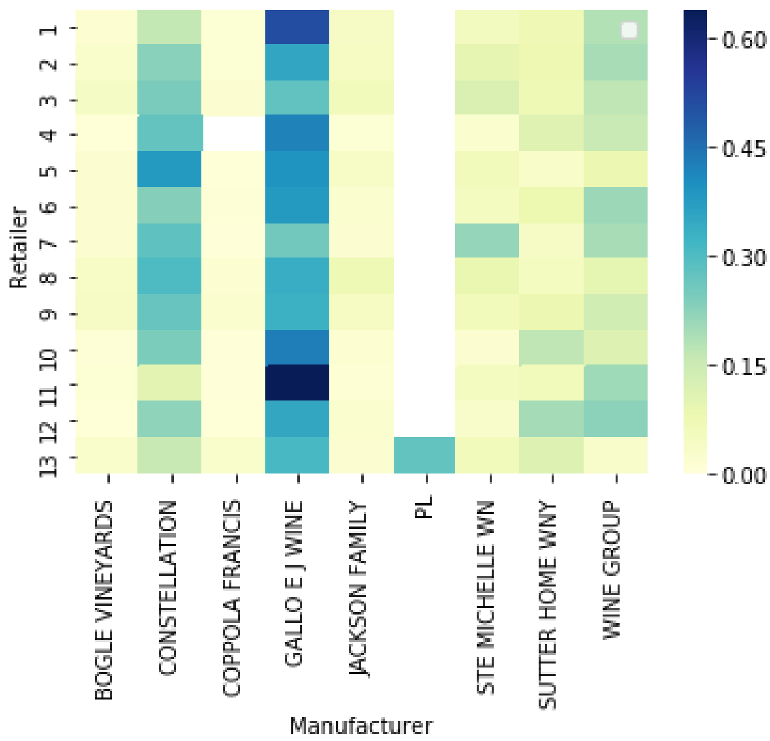
Table 1 in the Appendix contains sample averages for retailers. The first 10 retailers are supermarkets and the final three are mass-market retailers. Not surprisingly, the mass merchandisers (MMs) have a wider geographic spread, offer fewer products, and charge lower prices than most supermarkets on average. However, the average market share in a given market is lower at the MMs. This might be because consumers do not normally shop for wine at these types of stores. However, Retailer 13 has a greater average market share than the other MMs, which might be due to the PL presence. Finally, supermarkets tend to advertise wines more often than MMs (except for Retailer 11). This also makes sense, as dedicated supermarkets tend to be higher-service, higher-cost options than MMs.

Table 2 contains sample averages for manufacturers. These manufacturers compete across all counties in my sample, but the number of products offered varies widely. The largest manufacturers, Constellation and EJ Gallo, offer many products at a range of prices. Another tier of manufacturers (Francis Coppola, Jackson Family, and Ste Michelle) offer only a few pricier products. Finally, Trinchero, Wine Group, and the PL supply the cheapest products on the market, on average. In this table, market share is defined as the average sum of market share for all products produced by the manufacturer in a given market. Therefore, one can divide market share by the number of products to get some sense of average product market share. In particular, this figure for PL products is about 0.05%, making them one of the more popular products in the sample. This indicates that the PL plays an important role in the bargaining game.

Table 3 contains summary statistics for PL products versus NB products at the retailer who offers the PL. All variables are averages at the product-market level. PL products are cheaper and bought more often than NB products, which is partially because the PL is sold in large containers (e.g., 3 liter boxes). In addition, PL products are advertised more frequently than NB products. This highlights the retailer's interest in promoting its own products.

Finally, Figure 3 provides a visualization of dependence across retailer-manufacturer combinations. Reading across columns, each square measures the percentage of units sold at a particular retailer produced by a manufacturer. Therefore, each row sums to one. One observation is that some manufacturers are uniformly more important across all retailers (e.g., Gallo). However, this level of dependence varies across retailers: Retailer 11 relies more heavily on Gallo than Retailer 7. Along with the absolute number of sales, this variation in dependence across retailers drives differences in bargaining position, which will be important for identifying bargaining power.

Figure 3: Share of Units Sold Conditional on Retailer



Control State Price and Sales Data

As explained in the identification section, I need to observe either wholesale prices or marginal cost in the private retailer data to identify bargaining power parameters. However, proprietary wholesale price data is difficult to obtain, and thus I do not observe the associated wholesale prices negotiated by the retailer. To circumvent this issue, I use wine sales data from Pennsylvania, New Hampshire, Utah, and Montgomery County, Maryland in 2015 in order to estimate marginal costs for a common set of products. The data was compiled by the National Alcohol Beverage Control Association, an organization which collects data for alcohol control states. These jurisdictions control almost all distribution and sales of wine. In each of these states, I observe the retail price, 9 liter cases sold, and "freight-on-board" price at the month-UPC level. Freight-on-board price is the amount the state is charged by the manufacturer for a case of that product, in which transportation costs from the manufacturer to the state are borne by the manufacturer. Table 4 contains sample averages by manufacturer for Montgomery County, Maryland.

One peculiarity with these alcohol control jurisdictions is that they must set a fixed markup by law. For example, before 2017 Montgomery County's Department of Liquor Control was forced to charge a markup of 72.8% (presale) over manufacturer costs by law (Montgomery County DLC, 2015), and Pennsylvania was forced to charge a 30% markup over wholesale price before 2016 (Miravete, Seim, & Thurk, WP). In the data, this markup rule predicts the retail price quite closely. I report the average retail markup as a percentage above wholesale price in Montgomery County in Table 4. This percentage is fairly constant across manufacturers, hovering somewhere between 55% and 65%. There is some variation in markup due to heterogeneous sales, which are prenegotiated between the manufacturers and the state. Apart from these sales, states have no real ability to price their products; instead, manufacturers set prices indirectly through their choices of wholesale prices. For this reason, I model the state pricing game as Nash-Bertrand competition in wholesale prices between manufacturers.

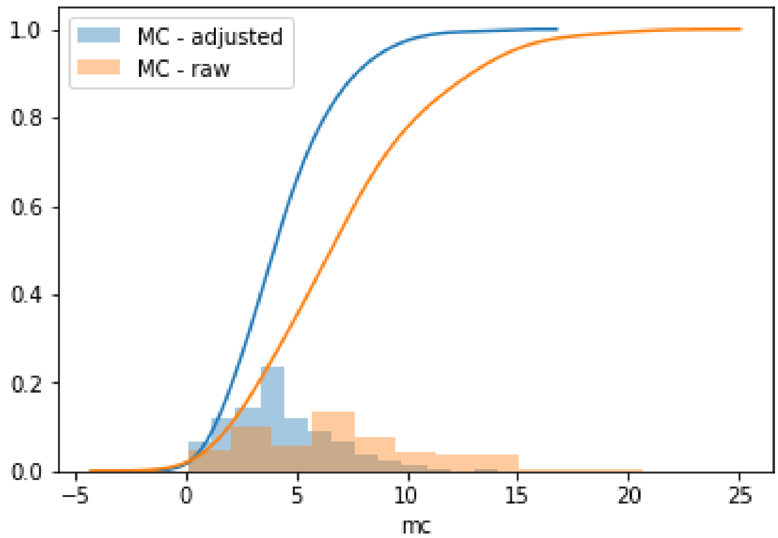
Results

Alcohol Control State Estimates

I report demand estimates for the multinomial logit model using the alcohol control state data in Table 5 in the Appendix. The price coefficient estimate is of the expected sign, but the coefficient on wine rating is negative and significant at the 10% level. This might be due to the lack of variation in wine ratings (most vary between 80 and 90 in this dataset), but consumers of mass-market wines might not value quality as much as serious oenophiles. The marginal costs are estimated by evaluating Equation 8 in each market, then running the regression in Equation 9. I cannot obtain marginal cost estimates for the PL products because by definition, they are only offered by the private retailer.

Figure 4 shows the distribution and density of marginal per-liter cost estimates before and after netting out market-specific costs. Not surprisingly, netting out the market-specific effects of cost causes the distribution of estimated costs to shift to the left. For the adjusted cost distribution, most of the estimated costs fall between $0 and $10 per liter. The mass toward $0 is primarily composed of boxed wines, which are sold in large sizes and thus the price per liter and estimated cost per liter are quite low. The mean and median per-liter cost estimate is about $3.50. While this might seem like a low production cost, many of the wines in the data are lower-end, mass-market wines.

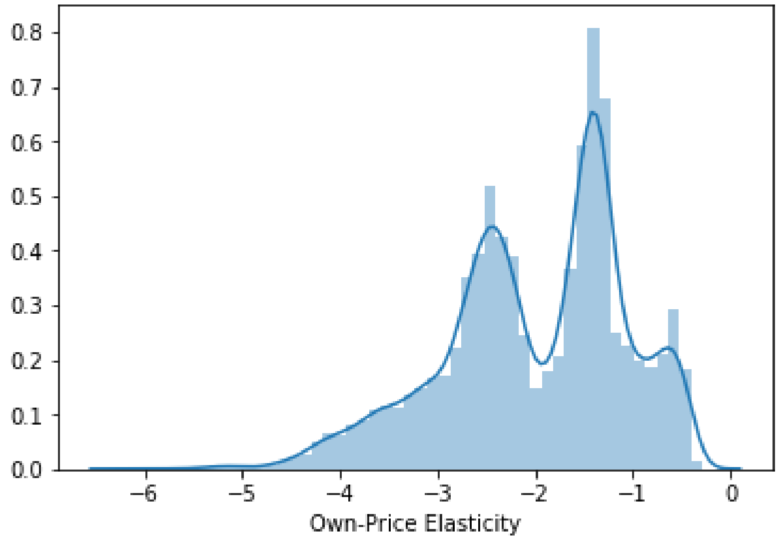
Figure 4: Distribution of Marginal Cost Estimates



Private Retailer Demand Estimates

I report demand estimates from the multinomial logit model using the private retailer data in Table 6 in the Appendix. The price coefficient estimate is of the expected sign and similar to that of the state data. The coefficient on rating is not significantly different from zero, which is likely for the same reasons given in the previous section. The coefficients on the advertising variables (feature and display) are positive and significant at the 5% level. As seen in Figure 5, the majority of own-price elasticities implied by these estimates fall between -1 and -5, and one would expect wine to be price elastic due to its nonessential nature and large selection of products.

Figure 5: Distribution of Own-Price Elasticities



Bargaining Model Estimates and Analysis

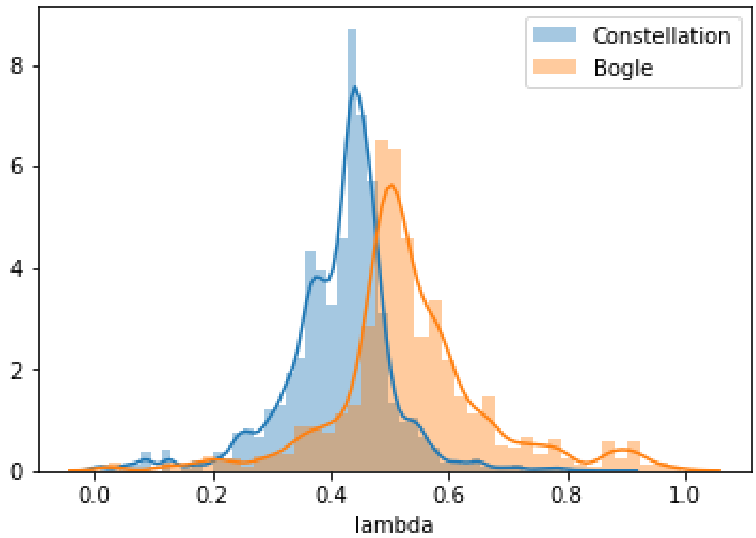
I report estimates of the bargaining power parameters in Table 7 in the Appendix. The reported parameters are averaged across markets, and since the parameters were estimated market by market, the standard deviations reported in the table capture variance in the estimated coefficients across markets.[10]

Only a few of the bargaining power estimates across markets are significantly different from 0.5, indicating that manufacturers and retailers have roughly equal negotiating skills and that bargaining position is the key determinant of the split of channel profit. However, there are interesting correlations between bargaining power estimates and firm characteristics. Table 8 contains estimates from regressing bargaining power on various retailer and manufacturer characteristics. As the market share of a particular manufacturer increases at a particular retailer by 1%, retailer bargaining power falls by 0.039. This measure is a proxy for bargaining position, so retailer bargaining position and bar-

[10] I am currently obtaining bootstrapped standard errors.

gaining power are positively correlated. In addition, larger firms tend to have higher bargaining power. Figure 7 shows the distribution of estimated retailer bargaining power parameters for Constellation (large firm) and Bogle (small firm). Constellation's distribution is much lower than Bogle's, which means that Constellation tends to have greater bargaining power with retailers than Bogle.

Figure 6: Distribution of Retail Bargaining Power Estimates, by Firm



I also estimate profits for each firm. Table 9 reports total profit estimates across all markets for each firm, and Table 10 reports the estimated percentage of channel profit going to the retailer, $(\frac{p-w}{p-c})$, averaged across markets. Similar to the bargaining power estimates, the average split of channel profits is close to 50% for all retailers and manufacturers. The figures differ slightly because the equilibrium channel split is determined by both bargaining power and bargaining position (i.e., disagreement profit). One key result is that when including PL sales, Retailer 13 has an average channel profit share of 52.8%, which is on the upper end for retailers. This is in part due to the PL's larger percentage margins over cost than those for NB wines (average gross margins of 63% for PLs versus 31% for NBs). However, part of this increase in channel profit share is due to the PL's ability to improve bargaining position. I calculate this effect in the next section.

For manufacturers, the same patterns apply to channel profit split as bargaining power. Smaller manufacturers, notably Bogle, receive a lower average share of channel profit (42.7%) than larger manufacturers such as Constellation (56.1%). This makes intuitive sense because smaller manufacturers have a worse bargaining position compared to larger manufacturers. One other key result concerns matching the average gross margin for manufacturers ($\frac{w-c}{w}$) reported by Moss Adams, LLP in their 2013 survey of wineries. They report that the average gross margin in their sample is 51%, while the mean in my sample is 49%. These figures are fairly close, so my estimates do not appear to be far off from industry averages, as reported directly by manufacturers.

Counterfactuals

Private Label Profit Decomposition

With the bargaining power estimates, I can determine how the presence of the PL affects retailer and manufacturer profits. In a similar study, Ellickson, Kong, and Lovett (working paper) decompose the profit effects of offering a PL into three components: the direct effect of PL sales, the substitution of sales from NBs, and the effect of the PL on improving bargaining position with NB manufacturers. To capture these effects, I treat PL products as if they are NBs and grant the PL producer a retailer bargaining power of $\lambda = 0.5$. I then use the estimated parameters to re-solve the bargaining problem with the counterfactual bargaining power. Changes in sales can be measured by comparing market shares in the two scenarios, and the change in NB margins captures the bargaining effect. Unlike Ellickson et al. (WP), I do not remove PLs from the market. In this way, I do not change the number or identity of products on offer, but only the PL status.

Effect of the PL on Firm Profits

I first compute change in total profits to retailers. Let G_{PL} be the set of PL products and let tilde denote values in the counterfactual no-PL scenario. Focusing on the PL retailer (13), the total change in profit is:

$$\Pi_{13} - \widetilde{\Pi}_{13} = \sum_{j \in G_{13}} (p_j - w_j) D_j - \sum_{j \in G_{13} - G_{PL}} (\tilde{p}_j - \tilde{w}_j) \widetilde{D}_j.$$

The first component of the total change is the change in retailer margins on PL sales:

$$\sum_{j \in G_{PL}} \big((p_j - w_j) - (\tilde{p}_j - \tilde{w}_j) \big) \widetilde{D}_j.$$

The second component is the change in demand for NBs when the PL is no longer owned by the retailer (I will call this the substitution effect from here on):

$$\sum_{j \in G_{13} - G_{PL}} (p_j - w_j)(D_j - \widetilde{D}_j).$$

The last component is the change in retailer margins on NBs (I will call this the bargaining effect from here on):

$$\sum_{j \in G_{13} - G_{PL}} \big((p_j - w_j) - (\tilde{p}_j - \tilde{w}_j) \big) \widetilde{D}_j.$$

Table 11 contains these values as a percentage of counterfactual profit across all retailers and markets. Positive values indicate that profit is higher when Retailer 13 owns the PL (actual scenario). Retailer 13's profit increases by an estimated 16.8% by owning its PL, but this is the net effect. The retailer earns 19.47% more profit on PL sales by owning its PL but loses 20.3% of profit on substitution away from NB products. This is because when Retailer 13 owns the PL, it negotiates higher prices on NB products to divert demand to the PL. However, Retailer 13 also earns 17.6% higher profit due to increased margins on NB products. Retailer 13 obtains higher margins on NB products when it owns the PL because it has greater bargaining position with NB manufacturers. I identify 17.6% as the "bargaining effect" of PLs on profit.

I also draw conclusions about how competing retailers are affected by PL ownership. Since the other retailers do not offer a PL, their total change in profits is the sum of the substitution and bargaining effects. All other retailers are worse off when the PL is offered, with profit losses ranging from 0.09% to 10.33% compared to the no-PL case. For most retailers, this decrease is due to negative bargaining effects. It appears that while the PL is certainly profitable for Retailer 13, it imposes negative bargaining externalities on competing retailers. To understand why, I perform the same exercise for manufacturers.

The substitution and bargaining effects for manufacturers are defined the same as before, except the relevant margins are $w - c$. Table 12 contains these values for all manufacturers across all markets. Negative values indicate that profit decreases when Retailer 13 offers the PL. Profits are lower for nearly all manufacturers when Retailer 13 offers the PL, but the cause for this drop varies by manufacturer. Most manufacturers have a positive bargaining effect, indicating that they achieve *higher* margins when the PL is offered. This is particularly true for the smaller, higher-end manufacturers such as Francis Coppola and Jackson Family. On the other hand, these manufacturers negotiate higher prices for their products in the no-PL scenario, which causes substitution away from those products. Large manufacturers tend to earn lower margins when the PL is offered, as evidenced by the negative bargaining effects for Gallo, Trinchero, and Wine Group. These firms rely heavily on lower-end wines which compete heavily with the PL, so their bargaining position is worse when negotiating with Retailer 13 compared with higher-end manufacturers. While manufacturers are worse off, they are not harmed as much as retailers in terms of the percentage of profit lost. Thus, manufacturers' bargaining position improves relative to the non-PL retailers and explains why most non-PL retailers have a negative bargaining effect.

Private Label Quality Choice

As another counterfactual, I choose a retailer to introduce a new PL product and determine its optimal product positioning. For this example, I specify Retailer 11 as the owner of the new PL.[11] Like Retailer 13, Retailer 11 is a mass merchandiser and has a relatively low average market share. However, what quality level should Retailer 11 choose for the new PL in order to maximize profit? As explained in the previous section, the retailer must not only account for direct PL sales but also the indirect effects the PL has on NB profits.

To answer this question, I simulate market equilibrium allowing the PL quality to vary and identify the quality level that maximizes Retailer 11's profit. In a given market, define the mean utility level from purchasing product j as $\delta_j = \beta X_j - \alpha p_j + \xi_j$. I then regress δ_j on marginal cost, type, and retailer fixed effects to obtain a predicted mean utility level for the new PL:

$$\delta_j = \gamma_0 c_j + \gamma_1 retailer_j + \gamma_2 red_j + \epsilon_j. \tag{13}$$

Given this equation, product placement is then defined as the choice of marginal cost. While not a direct measure of product quality, product cost can give managers some idea as to which brands to emulate when designing a PL.[12] Assuming $\gamma_0 > 0$, choosing a higher cost will make the product more attractive to consumers but at a higher production cost for the retailer.

Figure 7 shows how Retailer 11's profit changes as it adjusts the costs of the new PL. Profits are summed for all markets in Washington state.[13] The blue line plots the

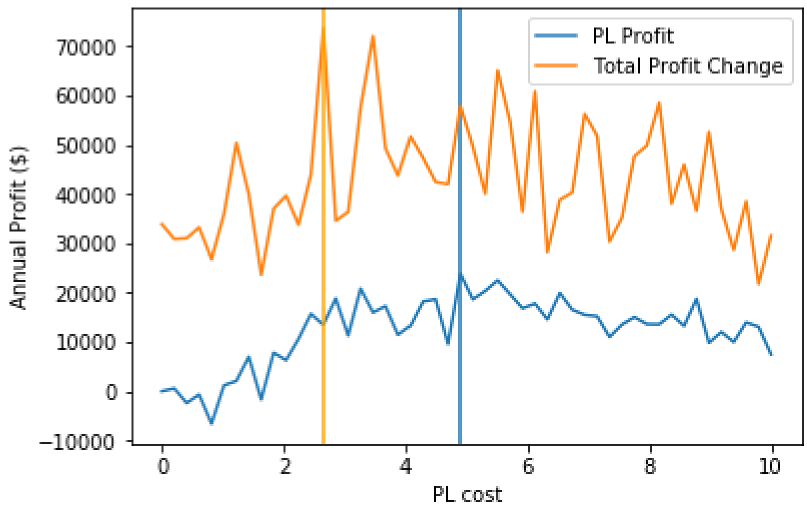
[11] This exercise could be performed with any retailer.

[12] This methodology is an initial attempt at the endogenous quality choice problem. A more rigorous approach would require explicitly modeling the endogenous quality choice in a first-stage game before bargaining. I leave this to future work.

[13] This exercise can be performed for all markets, but I limit it to Washington state to reduce computation time. In addition, Washington allows retailers to buy directly from manufacturers, so ignoring distributors in the vertical channel should not affect the results.

direct profit from PL sales, while the orange line shows the total change in profit across all products. Retailer 11's total profit is maximized when it sets the marginal cost of the new PL at around \$2.65/liter (earning 14.5% higher profit than in no-PL case), but choosing a cost of around \$5/liter would maximize PL profit. The two values differ because of the bargaining effect of offering the PL on other channels. Specifically, at the profit-maximizing cost choice, Retailer 11 would earn 10.6% higher margins on NB sales, compared to only 6.2% at the PL profit-maximizing cost choice. At a marginal cost of \$2.65/liter, this would make the PL comparable to brands such as Woodbridge Robert Mondavi, Black Box, and Red Diamond. This exercise shows that managers need to think about how product placement affects bargaining with other manufacturers and not just how it affects direct PL profit.

Figure 7: Change in Profit for Retailer 11 as Function of PL Cost



Comparison to Other Supply-side Models

Given the demand estimates in the private retailer setting, I estimate a selection of vertical supply models and compare key results with those of my model. I consider the following alternative models: ignoring the vertical channels, linear sequential wholesale pricing (classic double marginalization), and wholesale-only bargaining with Nash-Bertrand downstream competition (Draganska, Klapper, & Villas-Boas, 2010). The key outcomes I compare across models are marginal costs, wholesale prices, and firm profits.

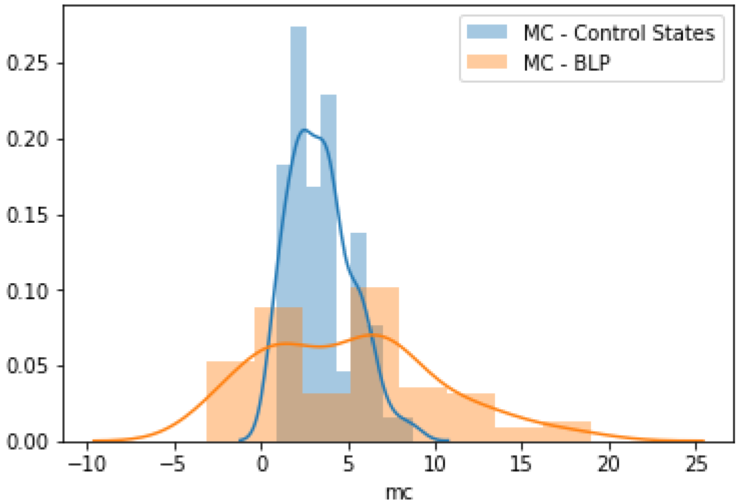
Manufacturer Nash-Bertrand

The first comparison model is Nash-Bertrand competition among manufacturers, which ignores the vertical channel. Specifically, each manufacturer solves the following problem simultaneously:

$$\max_{p \in H_m} \sum_{j \in H_m} (p_j - c_j) D_j. \tag{14}$$

The first order conditions of this problem in matrix form are written as $p - c = (\Omega \circ \Delta))^{-1} D(p)$, where Ω is the manufacturer ownership matrix and Δ is the demand-price derivative matrix. Thus, marginal costs are solved directly from this equation. This model ignores the vertical channel and has no wholesale prices, so the only comparison to make here is between marginal cost estimates. Figure 8 shows how the distribution of estimated marginal costs from this model compares with those from the state price-setting model, which I use as production costs in the bargaining model. The estimated marginal costs have higher variance in this model than in the state price-setting model. There is also a good deal of negative marginal cost estimates when using this model. These differences in marginal cost lead to differences in estimated channel margins ($p - c$), which affect channel profit calculations. Therefore, it is important to obtain marginal cost estimates from a setting in which we know the game being played by firms, which is exactly the case in control state pricing.

Figure 8: Density of Marginal Cost Estimates: BLP vs. State Pricing



Linear Sequential Pricing

The second comparison model is the linear sequential pricing model, which is the classic double marginalization model. In this game, manufacturers set wholesale prices first and retailers set retail prices given the wholesale prices. This model includes the vertical channel but allows for no coordination between upstream and downstream firms. In the second stage, retailer r maximizes its profit function over retail prices for all products in G_r given wholesale prices $\bar{w}$:

$$\max_{p} \sum_{j \in G_r} (p_j - \bar{w}_j) D_j. \tag{15}$$

In the first stage, manufacturer m maximizes its profit function over all wholesale prices for products in H_m in anticipation of optimal downstream pricing:

$$\max_{w} \sum_{j \in H_m} (w_j - c_j) D_j\big(p(w)\big). \tag{16}$$

The solution to this problem can be found in Meza and Sudhir (2010). For PL products, I assume that the retailer solves the pricing problem facing the margin $p - c$ as in the first model. This model has distinct predictions for marginal cost, so I first compare those to the marginal cost estimates from the state bargaining game. Figure 9 shows how the distribution of estimated marginal costs from this model compares to the one I use in the bargaining game. The linear model marginal cost estimates are tightly packed between \$0 and \$5 per liter, which seems quite low for such a wide variety of wines. Indeed, the average gross supplier margin implied by this model is 72%, which is much higher than the 51% reported by Moss Adams, LLP. The distribution of channel profit between the two models is also quite different; Figure 10 shows the distribution across all products in both models. The mean percentage of channel profit going to retailers in the linear model is 26.4% versus 53.2% in the bargaining model. This is because the manufacturer receives a first-mover advantage in the sequential pricing game. Finally, estimated channel profit is on average 21% larger in the linear model because of the lower marginal cost estimates.

Figure 9: Density of Marginal Cost Estimates: Linear vs. State Pricing

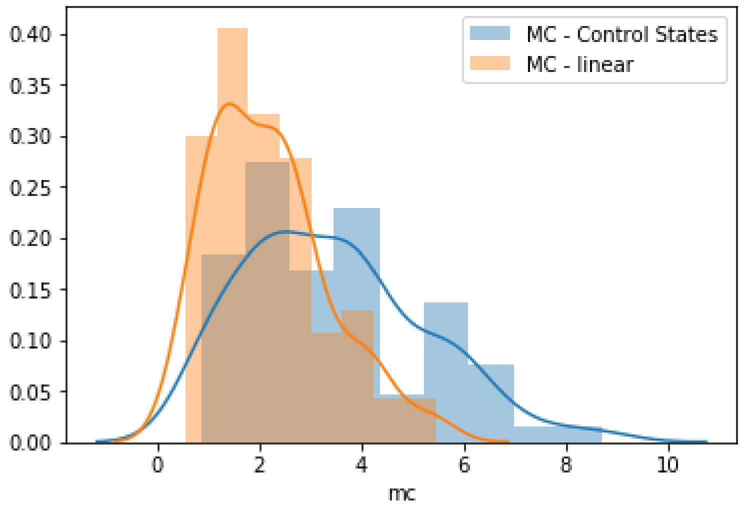
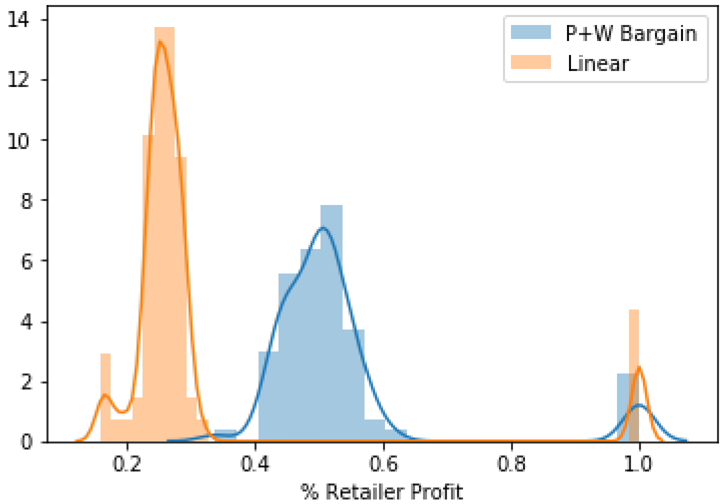


Figure 10: Density of % Retail Profit: Linear vs. P+W Bargaining



Wholesale-Only Bargaining

The third comparison model is the wholesale price-only bargaining model as outlined by Draganska, Klapper, and Villas-Boas (2010). Retailers compete in Nash-Bertrand competition. Specifically, retailer r chooses retail prices to maximize profit:

$$\max_{p} \sum_{j \in G_r} (p_j - w_j) D_j. \tag{17}$$

Simultaneously, retailers and suppliers bargain bilaterally over wholesale prices only. Using the notation from the earlier bargaining model, retailer r and manufacturer m solve the following problem for product i:

$$\max_{w_i} \left[\Pi_r - \Pi_r^{(-i)}\right]^{\lambda_{rm}} \left[\pi_m - \pi_m^{(-i)}\right]^{1-\lambda_{rm}}. \tag{18}$$

The detailed solution to this problem can be found in Draganska et al. (2010). They use a Nash-in-Nash equilibrium concept, as in the model presented in this paper. Briefly, solving for the equilibrium yields the following estimation equation:

$$p - m_r = \gamma \tilde{m}_w + \theta Z + \eta. \tag{19}$$

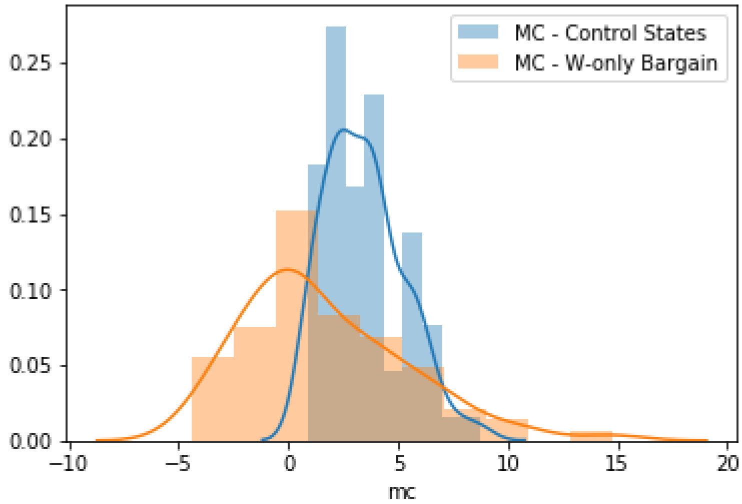
In the above equation, m_r and $\tilde{m}_w$ are the retailer and manufacturer margins derived from the model, Z is a matrix of cost shifters, and η is the unknown portion of marginal cost. $\gamma = \frac{1-\lambda}{\lambda}$ is a transformation of the retailer bargaining power parameters. This equation is linear and thus can be estimated using OLS. To allow λ to vary across retailer-manufacturer pairs, I interact $\tilde{m}_w$ with retailer-supplier indicators. For Z, I use product fixed effects rather than individual cost shifters, such as grape price. For PL products, I assume that $\lambda = 1$ as in my bargaining model.

I first compare bargaining power estimates because λ has the same interpretation in both models. Table 13 contains retailer bargaining power estimates averaged over all markets. Overall, retailer bargaining power is significantly lower in this model than in the two-price bargaining model, but there are some notable exceptions. For retailers, the mass merchandisers (Retailers 11-13) have higher average bargaining power than standard supermarkets, while all types of retailers have roughly equal bargaining power in my model. Most manufacturers have higher bargaining power than in my model, but certain firms have lower bargaining power (e.g., Ste. Michelle and Trinchero).

This model also has distinct predictions about marginal cost (from the model, $c_i = \theta Z_i$). Figure 11 plots the distribution of marginal costs from this model versus those from the control state estimation. Marginal cost estimates are almost uniformly lower in this model, and many of the lower-end products have negative cost estimates. However, the most apparent problem is that about 21% of estimated wholesale prices are lower than the marginal cost estimates. This violates rationality because if that were the case, the manufacturer would rather not sell the product to that retailer.[14] It appears that this model cannot rationalize much of the data in this study.

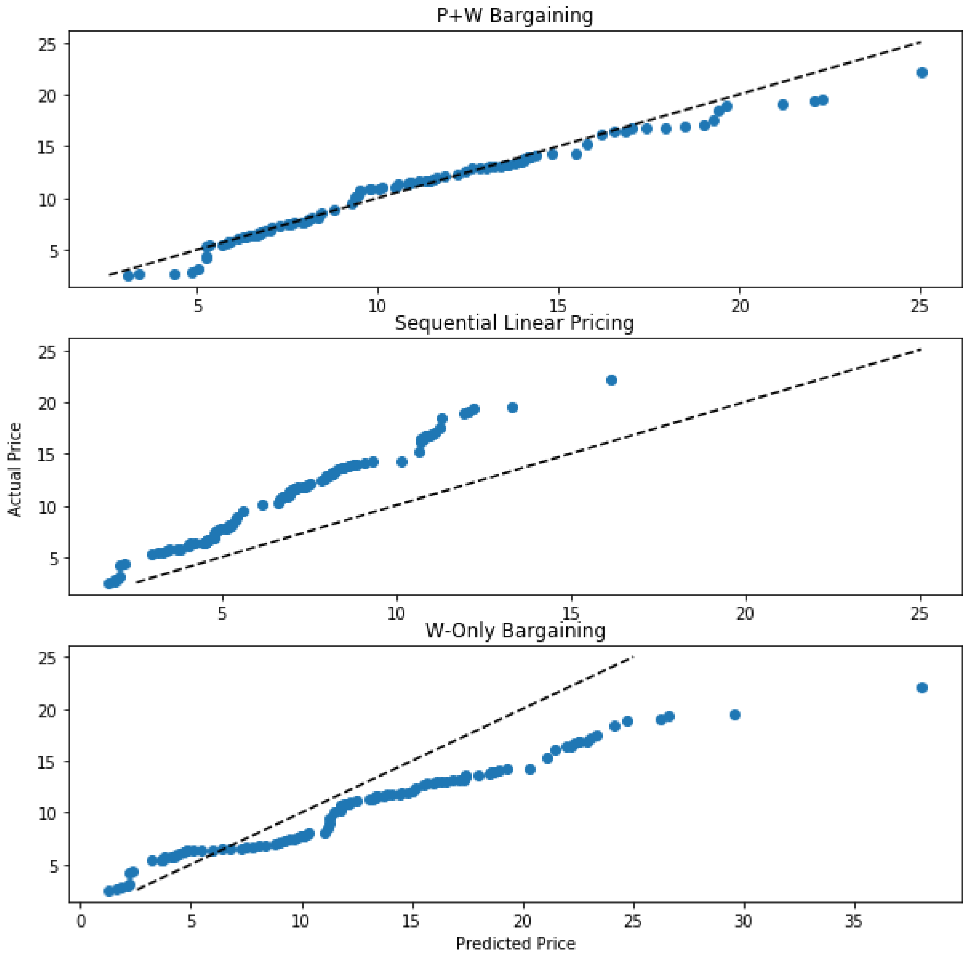
[14] The estimates for this model are highly sensitive to the cost specification, so I am still determining how to specify cost in order to obtain more reasonable results.

Figure 11: Density of Marginal Cost Estimates: Wholesale-Only Bargain vs. State Pricing



The previous results matter because researchers using those models have used the predicted marginal costs in their analysis, but I show that they are not reasonable compared to the marginal costs I obtain from a setting in which we know the game being played between firms. However, in order to provide a fair comparison between models, I solve for the retail prices predicted by each model using the *same* marginal costs from the control state estimation. Figure 12 shows quantile-quantile plots for predicted prices versus actual prices in one market. A point on the graph is the equivalent percentile in the price distribution in both datasets. Therefore, in the best-fitting model the points will fall closest to the 45 degree line. The figure shows that the price percentiles match best from my model, with only slight overprediction of prices at the higher percentiles. Sequential linear pricing underestimates the price of all products. The wholesale-only bargaining model predicts prices fairly well for products under $15/liter, but overpredicts prices past that point to a greater extent than my model. Overall, this figure shows that allowing for bargaining over both wholesale and retail prices best rationalizes the data compared to the other models.

Figure 12: Quantile-Quantile Plots of Predicted Versus Acutal Prices



Managerial Implications

The estimation exercise shows that retailers who offer PL wine are able to extract slightly higher margins (around 5%) on NB products, which amount to around $1 million in annual profit for Retailer 13. In terms of product positioning, the new PL introduction exercise shows that if a retailer has already decided to introduce a new PL product, it should consider the potential effects on its other products. The exercise shows that the PL quality choice that maximizes PL profit can differ from the choice that maximizes total profit due to the bargaining effects of the PL. Managers must recognize the externalities the PL imposes on other bargaining channels when deciding on product placement.

The PL quality choice exercise assumes that introducing a new PL is profitable for the retailer, but the choice to introduce a new PL is not truly exogenous. In reality, retailers must determine whether it is profitable to introduce a new PL in the first place. This study does not account for that decision, as there are both fixed costs of introducing a PL line (marketing, product design, etc.) and opportunity costs (forgone profit from replacing NB products with PL products in the presence of a shelf space constraint). Indeed, a wine buyer for a supermarket chain I interviewed reported that his chain does not offer a PL because of the unmodeled costs described above. However, the predictions offered by this model can help retailers determine whether those costs are worth bearing.

Conclusion

I introduce and estimate a new model of vertical bargaining between upstream and downstream firms in order to determine the effects of private label products on market outcomes. In particular, firms negotiate over both wholesale and retail prices, which better reflects anecdotal and empirical evidence of channel coordination in many retail industries. Theoretically, I show that manufacturers and retailers earn higher profits in this form of bargaining compared to wholesale-only bargaining (at least in partial equilibrium).

I estimate the bargaining model using data on domestic wine sales at a set of major US retailers. To identify the supply-side parameters, I use marginal cost estimates for the same set of products sold in alcohol control states. I find that the estimated retailer bargaining power parameters are close to 0.5 (indicating even bargaining power), and the percentage of channel profits going to retailers and manufacturers is roughly equal as well. I find that the presence of the private label leads to 5.1% higher profits for the private label retailer due to increased bargaining position with national brand suppliers, while most other retailers and manufacturers are harmed by the private label.

I compare the estimates from my bargaining model to three other models: Nash-Bertrand competition among manufacturers (i.e., ignoring the vertical channel), linear sequential pricing, and wholesale price-only bargaining. I find that marginal cost estimates from the Nash-Bertrand model differ significantly from those I obtain from the control state pricing game, which justifies the use of control state data in estimating the bargaining model. The linear sequential pricing model leads to low cost estimates and inflated channel profit estimates, and it predicts that retailers earn only a quarter of channel profits compared to half in my model. The wholesale-only bargaining model also predicts lower costs than the ones I use in estimating my model, and in many cases the wholesale-only model cannot rationalize the data. I also solve for the retail prices implied by each model using alcohol control state cost estimates, and I find that my model best matches the distribution of observed prices. These comparisons provide evidence that allowing for bargaining over both retail and wholesale prices produces the most reasonable results in this setting.

Finally, I show how managers can use the model to determine optimal product placement when introducing a new private label line. For a particular retailer, I relate private label cost to mean utility and solve for market equilibrium at different choices of private label cost. I show that the private label profit-maximizing cost choice and the overall profit-maximizing choice differ significantly due to the externalities private labels impose on other channels.

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Appendix

Theorem 1. *Suppose retailer r and manufacturer m are negotiating over product i. Assuming that all other contracts (p_{-i}, w_{-i}) are fixed, both r and m earn higher profits by bargaining over both p_i and w_i than only bargaining over w_i and letting r choose p_i independently.*

Proof. According to Equation 3, the first order condition with respect to w_i is:

$$\frac{\Pi_r - \Pi_r^{(-i)}}{\pi_m - \pi_m^{(-i)}} = \frac{\lambda_{rm}}{1 - \lambda_{rm}}.$$

This is identical to the first order condition with respect to w_i in the wholesale price-only bargaining game (refer to Draganska, Klapper and Villas-Boas (2010), equation 13). Thus, the ratio of gains from contracting are equal in both models assuming that λ_{rm} is the same. Equation 4 shows that the retail pricing FOC in the two-price bargaining game is equivalent to the retail pricing FOC where r and m act as an integrated monopolist over products in $G_r \cap H_m$. The following is also true:

$$\hat{p_i} = \arg\max_{p_i} \ \Pi_r + \pi_m = \arg\max_{p_i} \ (\Pi_r - \Pi_r^{(-i)}) + (\pi_m + \pi_m^{(-i)}).$$

That is, choosing p_i to maximize joint profits is identical to choosing p_i to maximize joint gains from contracting. This holds because $\frac{\partial \Pi_R^{(-i)}}{\partial p_i} = \frac{\partial \pi_m^{(-i)}}{\partial p_i} = 0$. Thus, two-price bargaining leads the firms to choose p_i such that joint gains from contracting are maximized.

In the wholesale price-only bargaining game, p_i is set only by the retailer:

$$\tilde{p_i} = \arg\max_{p_i} \ \Pi_r.$$

This necessarily means that $\hat{p_i} \neq \tilde{p_i}$. Because $\hat{p_i}$ is chosen to maximize total gains from contracting, then $\tilde{p_i}$ cannot also maximize total gains from contracting. Thus, total gains from contracting are larger under two-price bargaining. Since the gains from contracting are split the same way in both models, and the gains from contracting are larger in two-price bargaining, then both r and m earn higher profits using two-price bargaining. □

Table 1: Nielsen Retailer Sample Averages

Retailer	**Type**	**# Counties**	**# Prod**	**$/L**	**Share**	**% Sales Modeled**	**Feature**	**Display**
1	S	4	55.3	10.53	0.395	83.2	21.67	25.24
2	S	16	30.3	8.47	0.069	75.6	16.19	15.98
3	S	12	53.2	9.88	0.275	70.0	19.39	15.41
4	S	5	30.5	8.75	0.125	80.1	6.49	9.72
5	S	3	47.8	11.50	0.178	74.5	1.57	13.49
6	S	15	54.7	10.37	0.323	67.6	6.03	7.89
7	S	4	44.2	9.38	0.197	72.1	14.16	21.41
8	S	5	56.9	9.48	0.155	71.6	24.41	19.66
9	S	7	50.3	8.96	0.175	68.8	22.89	21.27
10	S	10	40.6	9.73	0.283	79.1	9.60	7.70
11	MM	25	15.5	6.00	0.043	79.1	14.21	9.33
12	MM	53	14.7	8.22	0.059	83.0	2.21	4.95
13 (PL)	MM	53	23.7	10.25	0.063	83.1	1.09	6.78

Table 2: Nielsen Manufacturer Sample Averages

Manufacturer	# Counties	# Prod	$/L	Share	Feature	Display
Bogle	53	4.19	12.44	0.011	15.24	9.53
Constellation	53	37.31	10.42	0.119	11.09	11.53
Francis Coppola	53	3.53	18.27	0.006	5.32	11.60
EJ Gallo	53	38.60	8.18	0.184	7.83	13.83
Jackson Family	53	4.65	16.80	0.015	22.53	13.80
Ste Michelle	53	12.70	13.34	0.034	11.84	13.69
Trinchero	53	6.90	6.88	0.043	8.09	9.25
Wine Group	53	16.95	6.54	0.081	7.04	5.20
PL	53	2.89	7.73	0.017	4.51	12.08

Table 3: Sample Averges for Products by PL, NB at Retailer 13

		Sample Averages			
Type	**# Prod**	**$/L**	**L Sold**	**Featured**	**Displayed**
NB	45	10.97	1248.33	0.616	6.59
PL	6	8.07	3158.40	4.24	11.86

Table 4: Manufacturer Sample Averages in Montgomery County, MD

		Sample Averages		
Vendor	**#Brands**	**Retail Price**	**Wholesale Price**	**Avg. Markup (%)**
Bogle	1	14.28	8.72	63.8
Constellation	24	12.70	8.05	57.8
Francis Coppola	3	13.43	8.64	55.4
Delicato	9	14.23	9.15	55.5
Deutsch	1	13.33	8.09	64.8
EJ Gallo	28	12.37	7.82	58.2
Jackson	14	18.16	11.53	57.5
One True Vine	1	13.91	8.18	70.0
Philps Michael David	3	23.88	14.94	59.8
Ste. Michelle	8	13.22	8.28	59.7
Trinchero	6	10.62	6.79	56.4
Treasury	13	13.30	8.35	59.2
Vintage	3	10.62	7.16	48.3
Wine Group	11	12.55	7.72	62.6

Table 5: Alcohol Control State Demand Estimates

Variable	β
Price	-0.271^{*} (0.024)
Rating	-0.090 (0.051)

$N = 1,825$. Regression includes state, quarter and product FEs. $*$ indicates estimate is significant at the 5% level.

Table 6: Private Retailer Demand Estimates

Variable	β
Price	-0.204^{*} (0.005)
Rating	-0.005 (0.003)
Feature	0.005^{*} (0.0004)
Display	0.005^{*} (0.0007)

$N = 27,209$. Regression includes county, quarter, retailer and product FEs. $*$ indicates estimate is significant at the 5% level.

Table 7: Mean Retail Bargaining Power Estimates by Retailer-Manufacturer Pair

	Bogle	**Const**	**FFC**	**Gallo**	**Jcksn**	**StMich**	**Trinch**	**WineGp**	**Mean**
1	0.594 (0.104)	0.429 (0.036)	0.536 (0.053)	0.508 (0.028)	0.550 (0.095)	0.477 (0.013)	0.478 (0.013)	0.444 (0.061)	0.480
2	0.521 (0.096)	0.436 (0.062)	0.511 (0.079)	0.500 (0.045)	0.512 (0.064)	0.437 (0.062)	0.483 (0.062)	0.499 (0.082)	0.482
3	0.516 (0.038)	0.424 (0.045)	0.508 (0.055)	0.479 (0.045)	0.490 (0.035)	0.456 (0.044)	0.534 (0.057)	0.391 (0.076)	0.453
4	0.508 (0.095)	0.466 (0.068)	*n/a* (*n/a*)	0.496 (0.042)	0.546 (0.080)	0.430 (0.082)	0.498 (0.052)	0.424 (0.090)	0.475
5	0.480 (0.161)	0.443 (0.045)	0.594 (0.110)	0.491 (0.032)	0.545 (0.149)	0.451 (0.039)	0.432 (0.072)	0.409* (0.040)	0.461
6	0.527 (0.074)	0.398 (0.052)	0.545 (0.081)	0.476 (0.061)	0.529 (0.063)	0.445 (0.043)	0.505 (0.045)	0.438 (0.090)	0.455
7	0.532 (0.039)	0.440* (0.017)	0.555 (0.104)	0.466 (0.021)	0.518 (0.057)	0.475* (0.012)	0.484 (0.020)	0.483 (0.036)	0.468
8	0.508 (0.027)	0.448* (0.024)	0.504 (0.041)	0.474 (0.019)	0.487 (0.009)	0.477 (0.021)	0.509 (0.028)	0.450 (0.066)	0.468
9	0.493 (0.024)	0.433 (0.045)	0.510 (0.062)	0.477 (0.033)	0.484 (0.043)	0.464 (0.031)	0.502 (0.037)	0.453 (0.043)	0.464
10	0.654 (0.207)	0.440 (0.041)	0.633 (0.180)	0.429 (0.045)	0.544 (0.100)	0.514 (0.093)	0.512 (0.030)	0.401 (0.074)	0.455
11	0.464 (0.138)	0.458 (0.132)	0.411 (*n/a*)	0.518 (0.070)	0.483 (0.173)	0.453 (0.100)	0.525 (0.121)	0.520 (0.132)	0.510
12	0.579 (0.234)	0.423 (0.102)	0.538 (0.176)	0.497 (0.060)	0.581 (0.136)	0.458 (0.148)	0.546 (0.103)	0.536 (0.162)	0.495
13	0.536 (0.103)	0.359 (0.131)	0.489 (0.111)	0.477 (0.075)	0.484 (0.145)	0.409 (0.104)	0.584 (0.109)	0.539 (0.138)	0.530
Mean	0.544	0.409	0.523	0.481	0.522	0.446	0.543	0.467	

Standard deviation of estimates across markets in parentheses. ∗ indicates estimate is significantly different from 0.5 at the 5% level.

Table 8: Factors Correlated with Retail Bargaining Power Estimates

Variable	β
Marginal Cost	-0.003 (0.004)
Market Share of M at R	-0.039 (0.020)
# Prod. M	0.0023^* (0.000)
# Prod. R	-0.0009^* (0.000)
Mass Merchandiser	-0.0321^* (0.011)

$N = 5,110$. Regression includes market, retailer and manufacturer FEs. $*$ indicates significance at 5% level.

Table 9: Estimated Aggregate Profits, by Firm ($ million)

Retailer	**Profit**	**Manufacturer**	**Profit**
1	12.44	Bogle	5.59
2	90.11	Constellation	47.21
3	25.76	Francis Coppola	5.40
4	3.57	EJ Gallo	54.79
5	6.91	Jackson Family	9.12
6	27.47	Ste Michelle	19.73
7	6.30	Trinchero	10.07
8	19.30	Wine Group	12.90
9	15.30		
10	7.10		
11	4.37		
12	12.90		
13 (PL)	20.37		

Table 10: Mean Retailer's % of Channel Profit Across Markets

	Bogle	Const	FFC	Gallo	Jcksn	StMich	Trinch	WineGp	Mean
1	0.640 (0.091)	0.499 (0.048)	0.582 (0.048)	0.572 (0.051)	0.601 (0.085)	0.540 (0.042)	0.602* (0.029)	0.620 (0.124)	0.556
2	0.525 (0.093)	0.433 (0.060)	0.514 (0.086)	0.487 (0.053)	0.515 (0.061)	0.437 (0.070)	0.487 (0.053)	0.518 (0.093)	0.474
3	0.560 (0.039)	0.489 (0.045)	0.543 (0.050)	0.570 (0.090)	0.527 (0.033)	0.500 (0.043)	0.611 (0.065)	0.551 (0.114)	0.531
4	0.524 (0.096)	0.465 (0.070)	n/a (n/a)	0.486 (0.034)	0.561 (0.077)	0.444 (0.082)	0.513 (0.057)	0.462 (0.098)	0.473
5	0.506 (0.167)	0.465 (0.058)	0.614 (0.108)	0.513 (0.034)	0.562 (0.148)	0.479 (0.045)	0.457 (0.148)	0.464 (0.099)	0.485
6	0.575 (0.073)	0.464 (0.036)	0.579 (0.076)	0.537 (0.065)	0.568 (0.064)	0.498 (0.044)	0.592 (0.047)	0.586 (0.127)	0.523
7	0.555 (0.035)	0.466 (0.026)	0.568 (0.104)	0.500 (0.032)	0.534 (0.055)	0.482 (0.011)	0.540* (0.019)	0.546 (0.060)	0.497
8	0.532 (0.027)	0.464 (0.031)	0.517 (0.043)	0.491 (0.028)	0.504 (0.015)	0.498 (0.035)	0.543* (0.021)	0.514 (0.085)	0.490
9	0.516 (0.029)	0.453 (0.041)	0.525 (0.054)	0.500 (0.049)	0.506 (0.048)	0.487 (0.042)	0.547 (0.043)	0.531 (0.084)	0.491
10	0.690 (0.193)	0.474 (0.047)	0.646 (0.170)	0.474 (0.052)	0.572 (0.097)	0.547 (0.090)	0.567 (0.038)	0.474 (0.052)	0.497
11	0.452 (0.128)	0.434 (0.123)	0.422 (n/a)	0.467 (0.084	0.469 (0.159)	0.427 (0.103)	0.508 (0.117)	0.494 (0.154)	0.473
12	0.591 (0.233)	0.422 (0.122)	0.543 (0.177)	0.483 (0.095)	0.589 (0.131)	0.464 (0.144)	0.546 (0.106)	0.529 (0.172)	0.478
13	0.548 (0.159)	0.382 (0.101)	0.498 (0.107)	0.472 (0.089)	0.497 (0.152)	0.419 (0.102)	0.586 (0.117)	0.552 (0.157)	0.528
Mean	0.573	0.439	0.543	0.503	0.545	0.476	0.563	0.541	

Standard deviation of estimates across markets in parentheses. $*$ indicates estimate is significantly different from 0.5 at the 5% level.

Table 11: Retailer Profit Change: Private Labels as National Brands

		Partial Effects		
Retailer	%$\Delta\Pi$	PL Sales	Substitution Effect	Bargaining Effect
1	-10.33%	n/a	2.96%	-13.29%
2	-1.36%	n/a	-0.09%	-1.27%
3	-2.27%	n/a	-0.01%	-2.26%
4	-0.11%	n/a	0.17%	-0.28%
5	-0.19%	n/a	0.98%	-1.17%
6	-4.34%	n/a	2.82%	-7.18%
7	-2.34%	n/a	-0.04%	-2.30%
8	-0.52%	n/a	-0.06%	-0.47%
9	-0.09%	n/a	-0.01%	-0.08%
10	-2.75%	n/a	5.50%	-8.25%
11	-6.30%	n/a	-0.01%	-6.28%
12	-5.10%	n/a	-0.35%	-4.75%
13	16.78%	18.67%	-20.25%	17.56%

Change in profits are aggregated across all markets. In counterfactual scenario, $\lambda = 0.5$ for the PL producer. Changes are computed as the difference between estimated values when $\lambda = 1$ and $\lambda = 0.5$ for PLs. Total market size is assumed to be the same in both scenarios.

Table 12: Manufacturer Profit Change: Private Labels as National Brands

		Partial Effects	
Manufacturer	%$\Delta\Pi$	Substitution Effect	Bargaining Effect
Bogle	-1.61%	-8.35%	6.75%
Constellation	-1.29%	-3.08%	1.79%
Francis Coppola	1.22%	-0.61%	7.28%
E&J Gallo	-2.42%	1.92%	-4.34%
Jackson Family	-3.04%	-11.22%	8.18%
Ste Michelle	-2.62%	-9.12%	6.50%
Trinchero	-1.68%	0.32%	-2.00%
Wine Group	-13.44%	1.23%	-14.67%

Change in profits are aggregated across all markets. In counterfactual scenario, $\lambda = 0.5$ for the PL producer. Changes are computed as the difference between estimated values when $\lambda = 1$ and $\lambda = 0.5$ for PLs. Total market size is assumed to be the same in both scenarios

Table 13: Mean λ Estimates, Wholesale-Only Bargaining Model

	Bogle	**Const**	**FFC**	**Gallo**	**Jcksn**	**StMich**	**Trinch**	**WineGp**	**Mean**
1	0.422* (0.037)	0.306* (0.057)	0.537 (0.057)	0.279* (0.034)	0.349* (0.025)	0.662 (0.084)	n/a (n/a)	0.337* (0.156)	0.356
2	0.401* (0.040)	0.332 (0.100)	0.484 (0.079)	0.281* (0.028)	0.352* (0.036)	0.539 (0.072)	0.622 (0.089)	0.395* (0.044)	0.381
3	0.458 (0.060)	0.277* (0.040)	0.579 (0.063)	0.304* (0.038)	0.395* (0.053)	0.639 (0.157)	0.735 (0.157)	0.387* (0.030)	0.387
4	0.360* (0.051)	0.415 (0.061)	n/a (n/a)	0.259* (0.039)	0.293* (0.030)	0.486 (0.085)	0.522 (0.100)	0.315* (0.041)	0.354
5	0.387* (0.060)	0.241* (0.063)	0.404 (0.056)	0.269* (0.043)	0.311* (0.029)	0.531 (0.091)	0.655 (0.139)	0.346* (0.032)	0.321
6	0.417 (0.053)	0.270* (0.046)	0.507 (0.068)	0.257* (0.027)	0.325* (0.040)	0.634 (0.139)	0.704 (0.167)	0.345* (0.034)	0.341
7	0.445 (0.030)	0.354 (0.158)	0.567 (0.053)	0.261* (0.012)	0.348* (0.017)	0.623* (0.058)	0.645* (0.037)	0.412* (0.023)	0.398
8	0.432* (0.032)	0.278* (0.080)	0.484 (0.044)	0.285* (0.019)	0.360* (0.018)	0.538 (0.056)	0.643 (0.076)	0.405* (0.035)	0.354
9	0.430 (0.035)	0.287* (0.026)	0.517 (0.082)	0.307* (0.034)	0.378* (0.030)	0.617 (0.086)	0.662 (0.092)	0.369* (0.047)	0.368
10	0.487 (0.063)	0.444 (0.185)	0.674 (0.121)	0.290* (0.043)	0.361* (0.044)	0.771 (0.161)	0.631 (0.105)	0.406 (0.051)	0.426
11	0.420* (0.035)	0.493 (0.085)	0.486 (n/a)	0.414 (0.136	0.436* (0.114)	0.573 (0.088)	0.625 (0.094)	0.399* (0.049)	0.452
12	0.413 (0.096)	0.316 (0.109)	0.477 (0.104)	0.317 (0.117)	0.313* (0.051)	0.560 (0.124)	0.569 (0.116)	0.375* (0.050)	0.408
13	0.408 (0.061)	0.272* (0.053)	0.490 (0.085)	0.280* (0.040)	0.347* (0.040)	0.555 (0.115)	0.543 (0.129)	0.372* (0.060)	0.441
Mean	0.425	0.314	0.506	0.293	0.348	0.601	0.587	0.375	

Standard deviation of estimates across markets in parentheses. $*$ indicates estimate is significantly different from 0.5 at the 5% level.